Effect of Different Nitrogen Levels on Growth, Yield and Yield Contributing Attributes of Wheat

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Abstract:

To evaluate the effect of different levels of nitrogen on growth and yield of wheat a field experiment was conducted in 2017-18 at research area of cereals and pulses section, Ayyub agricultural research institute, Faisalabad. Eight levels of nitrogen i.e. 0, 29, 58, 87, 116, 145, 174, 203 kg ha^{-1} were evaluated. Experiment was laid out under randomized complete block design (RCBD) with three replications with a net plot size of 10×5m. Data were recorded for growth and yield parameters like number of tillers, plant height, spiklets per spike, seeds per spike, biological yield, 1000 grain weight, grain yield and harvest index. Different levels of nitrogen significantly increased all the growth and yield parameters. Maximum number of tillers, highest plant height and biological yield was recorded from the treatment where nitrogen was applied @ 203 Kg ha^{-1} while 1000 grain yield, seeds per spike and grain yield was achieved highest from where nitrogen applied @ 145 Kg ha^{-1}.

Key Words:

Nitrogen levels, wheat growth and yield, plant height, biological yield, grain yield, harvest index

Introduction:

Wheat (*Triticum aestivum L.*) has the highest importance among the crops grown for the grain purpose worldwide. It is used as a staple food by 10 billion individuals over all the world mainly in 43 countries and contributing 30% to overall grain demand of the world standing at top in cereal crops. It gives around 20% of the aggregate food calories for mankind (Reddy, 2004). Being a main source of food for the people Pakistan, wheat is grown on a large area to fulfill its requirement. Regardless of its cultivation on large scale, Pakistani farmers are still unable to get the potential yield of wheat and their average production of wheat is far below than that (Mann *et al.*, 2004). According to economic survey of Pakistan, the total cultivated area under wheat was 8.734 million ha which was 2.6 % less in comparison to the last year cultivated area of 8.972 million ha. During 2017-18 total wheat yield was recorded 25.492 million tonnes showing a decrease of 4.4% as compared to the production of previous year which was 26.674 million tonnes. There were various factors involved in the low production of wheat including application of nitrogenous fertilizer in improper amount or no application of nitrogen, edaphic properties, availability and quality of irrigation water, prevailing climatic conditions and mismanagement of field operations by the farmers due to lack of knowledge and awareness.

Nitrogen is one of the major nutrients which reduce the yield of wheat if not applied in proper amount as it is needed for fast growth of plants and to get high production per hectare. Nitrogen play important role in all the metabolic processes of plants. Nitrogen is the main component and major constituent of plants especially in living tissues formation. Every single indispensable process in the plant are related with protein, of which nitrogen is a fundamental constituent. Nitrogen is an integral part of proteins, phytochromes, compounds, coenzymes, chlorophyll and nucleic acids. All the biochemical processes occurring in plants are mainly governed by nitrogen and its associated compounds which make it essential for the growth and development of wheat (Kutman *et al.,* 2011). Therefore, it is necessary to apply nitrogenous fertilizer in the soil to get bumper yields of wheat (Ali *et al.,* 2000). The varieties which have high genetic yield potential require high amount of nitrogen to produce their maximum production (Behera *et al.,* 2000).

To get the maximum yield of wheat, application of nitrogen in adequate amount is considered as a key to success. Application of nitrogen in splits has not considerable effect on economic yield, nevertheless it reduces the crop lodging and no. of spikes per plant, however 1000 grain weight increases (Ayoub *et al.*, 1994). Some of the researchers concluded from their experiments that by the application of nitrogen 120 kg per hacter maximum yield of wheat can be achieved (Lathwal and Singh, 1992, Das and Rao, 1993). (Geleto *et al.*, 1995., Singh and Uttam, 1992) concluded that the by increasing the amount of nitrogen application resulted in more no. of spikes, high yield of grains and more grain weight. According to several reports about the use of nitrogen in wheat, under favorable climatic and good management conditions the effect of nitrogen application from 90-225 kg per ha was not so significant (PENCKOWSKI *et al.,* 2009). In case of irrigated areas, the application of nitrogen up to 156 kg per ha showed an increasing trend of wheat grain yield i.e. 6472 kg per ha Heinemann *et al.* (2006). Many researchers (ESPINDULA *et al.,* 2010; TEIXEIRA FILHO *et al.,* 2007, 2010) reported the to get the maximum yield of wheat the optimum rate of nitrogen application is 70-120 kg per ha. Bruno Basso *et al.,* (2013) concluded that the application of nitrogen at 30 kg gave 2400-31000 kg ha^{-1}, 70 kg nitrogen resulted in 2650-3000 kg and 90 kg nitrogen produced 2650-3400 kg ha^{-1} of wheat yield.

Nitrogen insufficiency influences biomass synthesis and use of sun energy for productivity of the plant, with an extraordinary effect on grain yield and yield contributing parameters (Heinemann *et al.,* 2006). The inconsistency in soil and climatic conditions related with forms that influence nitrogen elements in the root zone and their association with the plant may prompt variation in nitrogen accessibility and its necessity to plant (Simli *et all.,* 2008 and Espindula *et al.,* 2010). Furthermore, the arrival of new cultivars with various requirement for their nutrition upsets summed up proposals of nitrogen fertilizers for wheat crop. The enthusiasm for boosting wheat yields has urged progressive farmers to perform the farm management operations intensively. It should be kept in mind that that the optimized level of nitrogen application should be low for the cultivar less responsive to its application and the rate of nitrogen should be high for the variety that is more responsive to its application and records more yield otherwise yield potential of the varieties would be decreased. However sometimes more application of nitrogen application results in toxicity and harms the plant growth by making it more susceptible to lodging, causing environmental pollution through nitrate leaching (Riley *et al.,* 2001) and volatilization in form of ammonia (Ma *et al.,* 2010), which become a cause of high cost production resulting in less net benefit to the farmers because only 1/3 part of applied nitrogenous fertilizer is taken-up by the cereal crops and assimilate it to their grains (Raun and Johnson, 1999).

In view of the importance of nitrogen for crop production present study is planned with the objectives to determine the optimum nitrogen requirement of the wheat crop.

Materials and Methods:

To evaluate the effect of different nitrogen levels on growth and yield of wheat (*Triticum aestivum L.*) an experiment was conducted in the research area of cereals and pulses section, Agronomic research institute, Ayyub agriculture research institute Faisalabad during Rabi 2017-18. The experiment was laid out in a randomized complete block design (RCBD) with three replications having a plot size of 5m × 10m. Line to line distance was maintained at 23cm apart while plant to plant distance was not maintained. The wheat variety Ujala-2016 was sown at the rate of 100kg ha^{-1} on 10 November 2017 through mechanical method using sowing drill. Before sowing, seed was treated with Benlate and Topsin-M solution following the standard recommendations to keep protect it from the soil borne diseases.

All the fertilizer including potash and phosphorus at the rate of 84, 62 kg ha^{-1} respectively while 1/3 portion of nitrogen (as per treatments) was incorporated in the soil at the time of seedbed preparation. All the other remaining Nitrogen was applied with the first irrigation. Potassium Sulphate, Single super phosphate and Urea were used as a source of fertilizer for Potash, Phosphorus and Nitrogen Respectively. To control narrow and broad leaf weeds Axial and Phonoxyprop were sprayed together at the rate of 825 and 750 ml ha^{-1} respectively after 40 days of sowing. All the other management practices were kept same in all the treatments, except those under study.

During that study eight different levels of nitrogen i.e. 0, 29, 58, 87, 116, 145, 174, 203 kg ha^{-1} were assessed. Data was recorded for the growth and yield contributing parameters like number of tillers m^{-2}, plant height, biological yield, number of spikelets per spike, number of seeds per spike, 1000 grain weight, grain yield and harvest index. To calculate spikelets per spike and seeds per spike, 10 spikes were taken from each plot. For 1000 seed weight, seeds were counted and weighed.

The data were analyzed statistically using STATIX 8.0 and LSD test was applied at 5% probability level to compare treatment means.

Result and Discussion:

Plant Height:

Different levels of nitrogen affected the plant height significantly (table 1). Maximum plant height (107.60 cm) was recorded from treatment T8 where nitrogen was applied @ 203 Kg ha^{-1} while minimum plant height was recorded form T1 where nitrogen was not applied. As the level of nitrogen increased plant was also gradually increased. Cells protein content increase as the application of nitrogen increase and size of plant cell increases, as a result of that leaf area and photosynthesis rate rises which ultimately make the plant taller (Wysocki *et al.*, 2007). Wheat growth can be increased by nitrogen by increasing the process of cell division and also help to uptake other nutrients from the soil through synergistic effect which increases the shoot length of

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plant (Asadie *et al.,* 2013). The increase in plant height was because nitrogen increases leaf area which results in high rate of photosynthesis, more production of assimilates and plant dry matter. These results are similar to Rahman *et al.*, (2014) and Liaqat *et al.*, (2003) who also reported that plant height was significantly increased by different doses of nitrogen.

Number of Tillers:

Number of tillers were significantly increased by different nitrogen levels (table 2). Maximum number of tillers m^{-2} (512.00) were recorded from T8 (203 Kg N ha^{-1}) while the treatment where no application of nitrogen was done gave the minimum number of tillers (264.00). Increased levels of nitrogen resulted in reduction of mortality of tillers and produced more tillers from the main stem. These results are confirmatory to those revealed by Rahman *et al.* (2014), Liaqat *et al.* (2003) and Kumar *et al.*, (2001).

Number of Spiklets/Spike:

Number of spiklets/spike were significantly different in treatments where no application of nitrogen (T1) was done and in T8 (203 Kg N ha^{-1}) while in other treatments means difference was non-significant. Maximum number of spiklets/spike (19.867) were recorded in T8 (203 Kg N ha^{-1}) while minimum number of spiklets/spike (18.533) were found in T1 where no nitrogen was applied. Nitrogen has mainly effect on the vegetative growth of plant while at reproductive stage its role is less considerable that's why different levels of nitrogen did not affect the number of spiklets/spike significantly. These results are in contradiction to Nerson *et al*. (1980) and Rahman *et al.,* (2014). Many researchers concluded form their studies that if there is more absorption of nitrogen by the plants produces more number of spikes per unit area, enhanced vegetative growth and more number of tillers per unit area (Donald, 1986; Nourmohammadi *et al*., 2010).

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Table 1. Effect of different nitrogen levels on growth and yield parameters of wheat.

Treatments	No. of tillers (m^{-2})	Plant Height (cm)	Biological Yield (g m^{-2})	1000 Grain weight	No. of spiklets per Spike	No. of seeds per spike	Grain Yield (Kg ha^{-1})	Harvest Index (%)
0 Kg N ha^{-1}	264.00^{F}	75.78^{F}	10044^{E}	32.461^{F}	18.533^{B}	28.5^{C}	1881.3^{H}	18.730^{E}
29 Kg N ha^{-1}	360.67^{E}	98.91^{E}	12710^{D}	38.919^{E}	18.900^{AB}	47.4^{B}	2189.3^{G}	17.227^{E}
58 Kg N ha^{-1}	381.67^{DE}	100.35^{DE}	12893^{D}	39.688^{DE}	18.933^{AB}	54.133^{A}	4623.2^{E}	35.857^{B}
87 Kg N ha^{-1}	386.67^{DE}	102.10^{CD}	14515^{C}	41.416^{BC}	19.333^{AB}	55.633^{A}	4818.8^{D}	33.203^{C}
116 Kg N ha^{-1}	392.33^{D}	102.83^{BCD}	14580^{C}	45.102^{A}	19.167^{AB}	56.800^{A}	5137.7^{C}	35.243^{B}
145 Kg N ha^{-1}	418.67^{C}	103.71^{BC}	14728^{C}	46.082^{A}	19.367^{AB}	58.367^{A}	5576.0^{A}	37.857^{A}
174 Kg N ha^{-1}	453.00^{B}	105.80^{AB}	15257^{B}	42.724^{B}	19.233^{AB}	60.133^{A}	5402.3^{B}	35.457^{B}
203 Kg N ha^{-1}	512.00^{A}	107.60^{A}	16134^{A}	40.861^{CD}	19.867^{A}	58.200^{A}	4127.0^{F}	25.730^{D}

Number of seeds/spike:

Number seeds per spike were also significantly increased by the high levels of nitrogen application. Maximum number of seeds/ spike (60.133) were recorded from T7 (174 Kg N ha^{-1}) that were also statistically similar to T3, T4, T5, T6 and T8 while minimum were observed no nitrogen applied treatment. Nitrogen promote the initiation of spiklets that resulted in more number seeds/spike but more nitrogen from 174 Kg N ha^{-1} level decreased the number of seeds due to increased vegetative growth as was observed in case of plant height. These results are quite in line with Gundapur and Bhatti (1993). Nitrogen fertilizer applied in optimum dose decrease the chance of seeds to deteriorate in the spikes otherwise in case of seed deterioration grain yield reduced (Seiling *et al.*, 2005).

1000 Grain Weight:

Due variation in nitrogen levels 1000 grain weight was significantly different. Maximum 1000 grain weight was found in T6 (46.082) statistically identical to T5 (45.102), while where nitrogen was not applied recorded the minimum grain weight (32.461). These results indicate that nitrogen has a key role in the growth and development of grain. These results are similar to those reported by Abedin (1995), Patel and Upadhyay (1993) who concluded that higher dose of nitrogen significantly increased grain weight.

Biological Yield:

Different levels of nitrogen fertilizer application increased biological significantly. Maximum biological yield (16134 g m^{-2}) was harvested from T8 (203 Kg N ha^{-1}), while minimum (10044 g m^{-2}) was recorded from the treatment where nitrogen was not applied. More application of nitrogen gave tall plants, more grain yield, number of tillers per unit and total dry matter which collectively resulted in higher biological yield. There are many studies which revealed that with increasing the nitrogen rate biological yield increased (Ghobadi *et al.*, 2010). During pollination high levels of nitrogen increased the total dry matter that help to get more grain yield McDonald (2002). Many other scientists reported that high levels of nitrogen yield in more straw and grain weight (Bulman and Smith, 1993; Camberato and Bock, 2001). As a result of more biological yield a plant with its large canopy is able to intercepts more sun radiation and produce more assimilates.

Grain Yield:

Wheat grain yield was also significantly increased by different levels of nitrogen. Maximum grain yield (5576 kg ha^{-1}) was obtained from T6 while minimum grain yield (1881.3 kg ha $^{-1}$) was recoded from the treatment where no application of nitrogen was done. Among all the essential nutrients applied to the plants nitrogen is the major one which has a key role in the process of photosynthesis. Increased rate of photosynthesis by the high dose of nitrogen gave more yield because large amount of dry matter, more assimilates were produced and transported to fill the seeds as a result of more applied nitrogen. In case of treatment where nitrogen was applied @ 203 Kg ha^{-1} crop lodging occur due to which yield was reduced dramatically.

Harvest Index:

Under different levels of nitrogen harvest index differ significantly. Maximum harvest index (37.857) was calculated from T6 (145 kg N ha^{-1}) while minimum Harvest (17.227) was calculated from T2 (29 Kg N ha^{-1}). When harvest index is low it means that there is less translocation of assimilates from the source to sink which results in less development of seeds and make them shrivled size. When harvest index is high it means that more assimilates were translocated from source to the grains which result in improved development and filling. Harvest index is directly associated with the plant dry matter and grain weight which ultimately depends upon the availability and uptake of nutrient specially nitrogen. The more will be the nitrogen amount the more will be growth and development but upto to a certain limit beyond that limit it can cause toxicity to the plant and reduce it yield (Uhart and Andrade, 1995).

Conclusion:

Concluded from the findings of current study that application of nitrogen @ 145 along with phosphorus 62 and potash 84 Kg ha^{-1} gave highest grain yield per hectare under irrigated conditions of Faisalabad.

References:

A. Ali, M.A. Choudhry, M.A. Malik, R. Ahmad and Saifullah (2000). Effect of various doses of nitrogen on the growth and yield of two wheat cultivar. Pak. J. Biol. Sci. 3(6): 1004-1005.

A. B. Heinemann, L. F. Stone, A. D. Didonet, M. G.; Soares, B. B. Trindade, J. A. A. Moreira, A. D Canovas, (2006). Radiation use efficiency solar wheat productivity resulting from fertilization nitrogen. Brazilian Journal of Engineering Agricultural and Environmental. v. 10, n. 2, p. 352-356.

Abedin M J. 1995. The impact of water and nitrogen on yield of wheat. M. S. Thesis. Dept. of Soil Science. IPSA, Gazipur – 1703.

B. L. Ma, T. Y. WU, N. Tremblay, W. Deen, N. B. Mclaughlin, M. J. Morrison, G Stewart, (2010). On-farm assessment of the amount and timing of nitrogen fertilizer on ammonia volatilization. Agronomy Journal. v. 102, n. 1, p. 134-144.

Bulman, P. and D. L. Smith. 1993. Yield and yield and components response of spring barley to fertilizer nitrogen. Agron. J. 85: 226-231.

D.K. Das, and T.V. Rao (1993). Growth and spectral response of wheat as influenced by varying nitrogen levels and plant densities. Annual of Agric. Res. 14: 421–425.

Donald, C. M. 1986. The breeding of crop ideotypes. Euphytica. 17: 385-403.

ESPINDULA, M. C.; ROCHA, V. S.; SOUZA, M. A.; GROSSI, J. A. S.; SOUZA L. T. Doses e formas de aplicação de nitrogênio no desenvolvimento e produção da cultura do trigo. Ciência e Agrotecnologia, v. 34, n. 6, p. 1404-1411, 2010.

F. F. Simili, R. A. Reis, B. N. Furlan, C. C. P. Paz, M. L. P. Lima, P. A. A. Bellingieri, (2008). Response sorghum-sudan hybrids to nitrogen fertilization and Potassium: chemical composition and in vitro digestibility of organic matter. Science and Agrotechnology. v. 32, n. 2, p. 474-480.

Ghobadi, M., M. E. Ghobadi and S. S. Sayah. 2010. Nitrogen application management in triticale under post-anthesis drought stress. Word Acad. Sci. Eng. Technol. 70: 252-254.

HEINEMANN, A. B.; STONE, L. F.; DIDONET, A. D.; TRINDADE, M. G.; SOARES, B. B.; MOREIRA, J. A. A.; CANOVAS, A. D. Eficiência de uso da radiação solar na produtividade de trigo decorrente da adubação nitrogenada. Revista Brasileira de Engenharia Agrícola e Ambiental, v. 10, n. 2, p. 352-356, 2006.

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Kumar R and Sharma S N. 1999. Effect of nitrogen on dry matter and nutrient accumulation pattern in wheat (*Triticum aestivum*) under different dates of sowing. Indian J. Agron. 44 (4): 738-744.

Liaqat, A., Q. M. U. Din and M. ALI. 2003. Effect of Different Doses of Nitrogen Fertilizer on the Yield of Wheat. Int. J. Agri. & Bio. 5 (4):438–439.

M. Ayoub, S. Guertin, S. Lussier and D.L. Smith (1994). Timing and levels of nitrogen fertility effects on spring wheat. Crop Sci. 34: 748–750.

M. Z. R., M. R. Islam, M. T. Islam and M. A. Karim. 2014. Dry Matter Accumulation, Leaf Area Index and Yield Responses of Wheat under Different Levels of Nitrogen. Ban. J. Agri. 7(1):27–32.

M. C. Espindula, V. S. Rocha, M. A. Souza, J. A. S. Grossi, L. T Souza (2010). Doses and forms of nitrogen application in the development and production of wheat crop. Science and Agrotechnology. v. 34, n. 6, p. 1404-1411.

M. C. M. Teixeira filho, S. Buzetti, M. Andreotti, O. Arf, C. G. S Benett, (2010). Doses, sources and timing of nitrogen application in wheat in irrigated tillage. Agricultural Research Brazilian. v. 45, n. 8, p. 797-804.

McDonald, G. K. 2002. Effects of nitrogen fertilizer on the growth grain yield and grain protein concentration of wheat. Aust. J. Agric. Res. 43: 949-967.

Nerson M, Sibony M and Pinthus M J. 1980. A scale of assessment of development stages of wheat spike. Ann. Bot. 45: 203-204.

Nourmohammadi, G.H., A. Siadat and A. Kashani. 2010. Cereal Crops, Ninth Printing. Chamran University Press, Ahvaz, Iran, p. 48.

O.P. Lathwal, and T. Singh (1992). Effect of irrigation and nitrogen levels on yield attributions and yield of wheat. Haryana J. Agron. 8:69–70.

Patel R M and Upadhyay P N. 1993. Response of wheat to irrigation under varying levels of nitrogen and phosphorus. Indian J. Agron. 36 (1): 113-115.

PENCKOWSKI, L. H.; ZAGONEL, J.; FERNANDES, E. C. Nitrogênio e redutor de crescimento em trigo de alta produtividade. Acta Scientiarum. Agronomy, v. 31, n. 3, p. 473-479, 2009.

R.A. Mann, W.A. Jehangir and I. Masih (2004). Improving crop and water productivity of rice-wheat system in Punjab, Pakistan. In: Proceedings of the 4th International Crop Science Congress, Brisbane.

Reddy, S.R 2004. Agronomy of Field Crops. Kalyani Publishers.

Sieling, K., C. Stahl, C. Winkelmann and O. Christen. 2005. Growth and yield of winter wheat in the first 3 years of a monoculture under varying N fertilization in NW Germany. Eur. J. Agron. 22: 71-84.

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T. Geleto, D.G. Tanner, T. Mamo and G. Gebeyehu (1995). Response of rain fed bread and durum wheat to source level and timing of nitrogen fertilizer on two Ethiopian vertisole S. I. yield and yield components. Comm. in Soil Sci. and Plant Analysis. 26: 1773–1794.

U. B. Kutman, B. Yildiz, I. Cakmak, (2011). Effect of nitrogen on uptake, remobilization and partitioning of zinc and iron throughout the development of durum wheat. Plant and Soil. v. 342, n. 1-2, p. 149-164.

U.K. Behera, B.A. Chougule, R.S. Thakur, K.N. Ruwali, R.C. Bhawsar and H.N. Pandey (2000). Influence of planting dates and nitrogen levels on yield and quality of durum wheat (Triticum durum). Indian J. Agric. Sci.70: 434–6.

Uhart, S. A. and F. H. Andrade. 1995. Nitrogen deficiency in maize: I. Effects on crop growth, development dry matter partitioning and kernel set. Crop Sci. 35: 1376-1383.

V.P. N. Singh, and S.K. Uttam (1992). Response of wheat cultivars to different N levels under early sown conditions. Crop Res. 5: 82–86.

W. J. Riley, I. Ortiz-Monasterio, P. A Matson, (2001). Nitrogen leaching and soil nitrate, nitrite, and ammonium levels under irrigated wheat in Northern Mexic. Nutrient Cycling in Agroecosystems. v. 61, n. 3, p. 223-236.

W. R. Raun, G. V. Johnson, (1999). Improving nitrogen use efficiency for cereal production. Agronomy Journal. v. 91, n. 3, p. 357-363.

Wysocki, D. J., M. Corp, D. A. Horneck and L. K. Lutcher. 2007. Nutrient Management Guide: Irrigated and Dryland Canola. Oregon State University EM-8943-E. Available from: http://www. extension.oregonstate.edu/catalog/pdf/em/em8943-e.pdf.

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